A New 1-ton Prototype Neutrino Detector at CJPL-Ⅰ China

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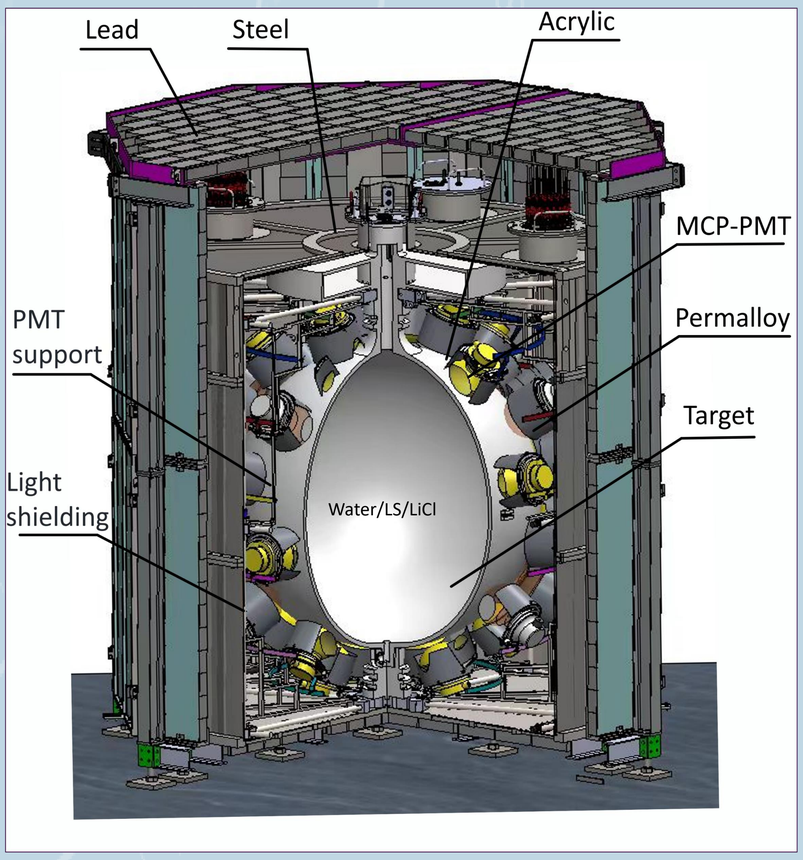
Ⅰ Motivation

- The detector is a prototype for the future Jinping Neutrino Experiment (JNE).
- Determining performance and stability of the new PMTs and new electronics used by the JNE.
- Improve the performance of the previous prototype detector(30 8-inch PMTs of Hamamatsu)[1].

Ⅱ Structure

- Target mass:
  - About 1 ton
- Acrylic sphere
- PMT:
  - 60 8-inch PMTs
  - Micro-channel plate (MCP)
- DAQ:
  - Self-developed
- Radiation shielding:
  - Water
  - Steel
  - Lead



Ⅲ New 8-inch MCP-PMT[2]

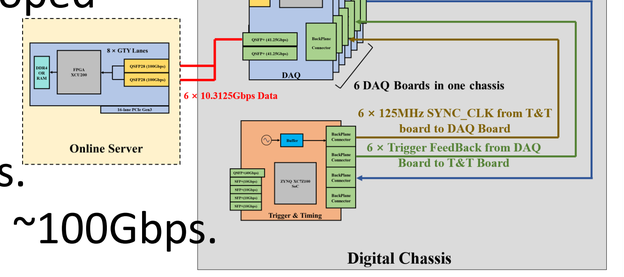
- Collaborated with Northern Night Vision to develop MCP-PMT:

1. High detection efficiency (~30%).
2. Low transition time spread (~1.6ns).
3. Low dark nose rate (5.8kHz).
4. Low background glass (^{226}Ra,^{232}Th,^{40}K).

Ⅳ New DAQ[3]

- Based on Tsinghua self-developed electronics :

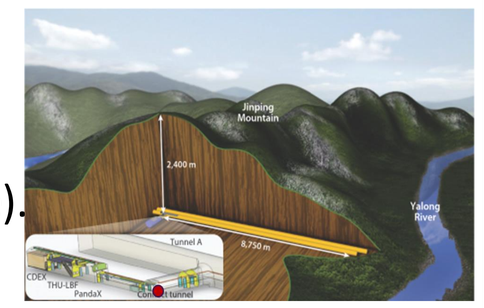
1. ENOB exceeds 9.8 bits.
2. Max clock deviation is 85.6ps.
3. High transmission capability, ~100Gbps.



Ⅴ Clean environment[1]

- In the 2400 m underground:

1. Low cosmic ray (<0.5 day^{-1}).
2. Low natural radiation (More granite).
3. Low reactor neutrino rate.



Ⅵ Construction

Acrylic sphere
- R=650 mm
- d=20 mm

PMT support
- 316L steel
- Supporting function

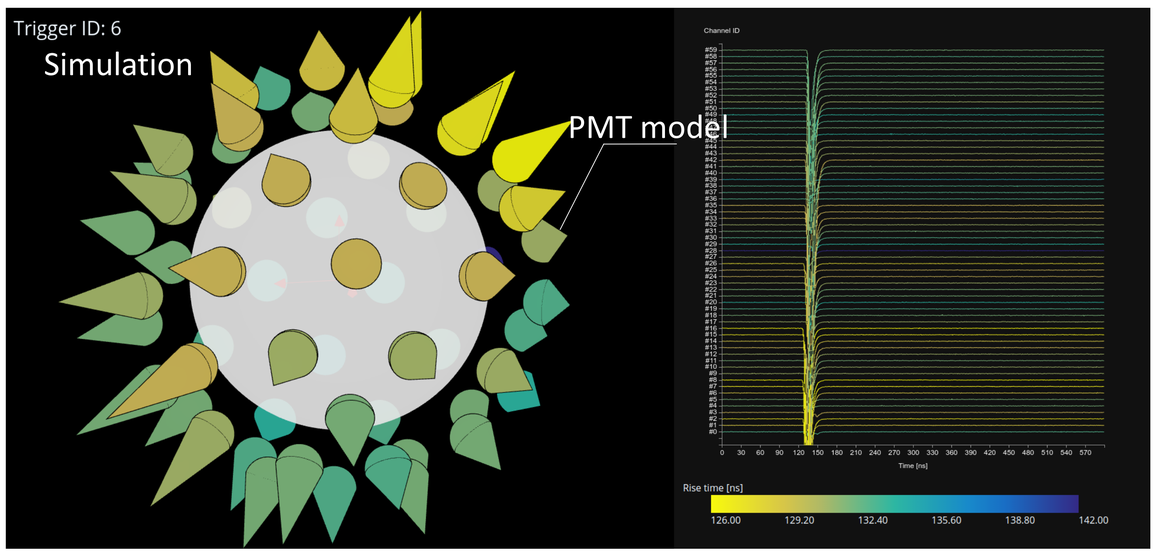
MCP-PMT
- Magnetic shielding
- Circular distribution

Light shielding
- A black shade cloth
- Prevent reflection

Steel cylinder
- 316L steel
- Light and radiation shielding

To be continued

Ⅶ Signal display

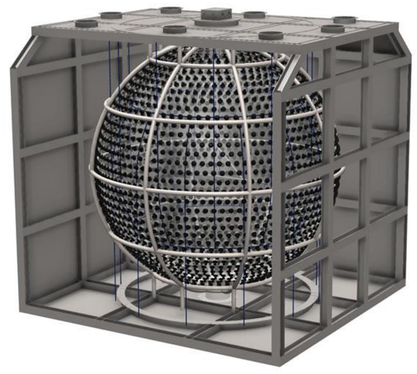


- Real-time display of events in this detector.
- Left side :
  - The size of PMT represents the strength of the signal.
  - The color of the PMT represents relative time.
- Right side:
  - The signal waveform recorded by the DAQ system.

Ⅷ Primary missions

1. For the JNE:
   - Determining and testing the MCP-PMT waterproofness and technical characteristics.
   - The new DAQ system was used for a long time to test its performance and stability.
2. Compared to the previous 1-ton prototypes:
   - Using more neutrino targets: water, liquid scintillator, and LiCl solution.
   - Decreasing the degenerations in the previous reconstructions of energy and location of events.

JNE Detector 500 tons



Reference
[1]. Yiyang Wu, Nucl.Instrum.Meth.A 1054 (2023) 168400
[2]. Aiqiang Zhang, Nucl.Instrum.Meth.A 1055 (2023) 168506
[3]. Lin Jiang, ArXiv:2404.10373.